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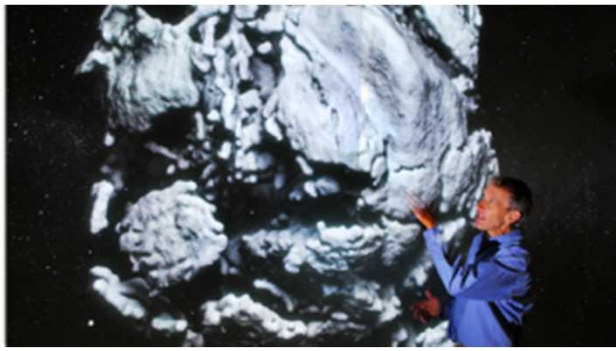

Transportation Models Analysis

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Jovana Helms, PhD
Sandia National Laboratories
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Transportation Models Analysis Objectives

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- Identify existing models for performing transportation analyses in support of the hurricane evacuation study (HES) process
- Evaluate model compatibility with HES process parameters
- Compare identified models with RtePM
- Identify requirements for RtePM use in HES process
- Validate RtePM against TIME

Transportation Model Types

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- Transportation Models can be classified in 4 categories:
  - ✓ **Macroscopic**: transportation elements are modeled on an aggregate, flow basis
  - ✓ **Microscopic**: transportation elements are modeled as individual units that interact with each other
  - ✓ **Mesoscopic**: intermediate resolution; transportation elements are treated as small groups without explicitly modeling behavior and inter-vehicle interactions at a high level of detail
  - ✓ **Hybrid simulation**: combined meso- and microscopic simulations

Models included in the study

- **Twenty-seven** models considered

  Down-selected to eliminate models that were not suitable for large-scale evacuation modeling, outdated/obsolete, or unable to automate for sensitivity analysis

- Six evaluated in depth:

Aimsun

Oak Ridge Evacuation Modeling System

PTV VISUM

TransModeler Traffic Simulation Software

Cube Avenue

DynusT

Feature comparison

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Feature	Aimsun	Cube Avenue	DynusT	OREMS	Trans Modeler	Visum	RtePM
Type	Hybrid	Meso	Meso	Macro	All Types	Hybrid	Macro
Road Data	Import	User Built	Import or User Built	User Built	Inbuilt, User Built	Import or User Built	Inbuilt from Navteq
ETE	✔	✔	✔	✔	✔	✔	✔
Road Seg Analysis	✔	✔	✔	✔	✔	✔	✔
Traffic Vol	✔	✔	✔	✔	✔	✔	✔
Pub Trans	✔	Manual	n/a	Manual	✔	✔	Fractional
Licensing Cost	$4,050-$43,200	$18,500	n/a	n/a	$7,000-$12,000	$1,950-$156,008	Free

Transportation Models Analysis Takeaways

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Based on our analysis no other macroscopic model would offer more than RtePM.

- There is a tradeoff between level of detail a model provides vs complexity of use and cost
- Microscopic models allow more detailed analysis
- If the program chose to use a microscopic model significant investments would have to made into:
  - ✓ Acquiring the model
  - ✓ Acquiring data
  - ✓ Setting up the model and customizing it for each jurisdiction

RtePM

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Investigated usability of RtePM for NC, NYC and Florida HES.

- Analysis performed on HES reports:
  - ✓ NC 2002 HES
  - ✓ NYC 2015 HES
  - ✓ FL 2015 HES
- Transportation analysis methodology and assumption for NC and NYC not available
- In its current state RtePM may be more suitable for some jurisdictions
- To accommodate HES process and to ensure tool adoption, improvements to RtePM are necessary

Exchanged information with Texas A&M TI on Valley Study Hurricane Evacuation Study Transportation Analysis

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 8: Monroe County
Identifier	S. FL HES
Evacuation Zone	C
Total Population	
Total Vehicles	29470
Tot. Pop. Evacuating	51,007
Tot. Evac. to Shelters	1,092
Population Change (%)	
People/Vehicle	1.7
% of Pop. Evac.	70
% using Private Vehicles	
Response curve (h)	12
Background Traffic	
In-County Clearance Time (h)	22.5

S. FL HES: South Florida HES Data

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 8: Monroe County	
Identifier	S. FL HES	Trial 1
Evacuation Zone	C	A/B
Total Population		89,438
Total Vehicles	29470	41737
Tot. Pop. Evacuating	51,007	62,606
Tot. Evac. to Shelters	1,092	0
Population Change (%)		10
People/Vehicle	1.7	1.5
% of Pop. Evac.	70	70
% using Private Vehicles		100
Response curve (h)	12	12
Background Traffic		None
In-County Clearance Time (h)	22.5	30.4

S. FL HES: South Florida HES Data

Trial 1: RtePM Population Data with HES parameters

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 8: Monroe County		
Identifier	S. FL HES	Trial 1	Trial 2
Evacuation Zone	C	A/B	A/B
Total Population		89,438	81,308
Total Vehicles	29470	41737	29270
Tot. Pop. Evacuating	51,007	62,606	58,541
Tot. Evac. to Shelters	1,092	0	0
Population Change (%)		10	0
People/Vehicle	1.7	1.5	2
% of Pop. Evac.	70	70	72
% using Private Vehicles		100	100
Response curve (h)	12	12	12
Background Traffic		None	None
In-County Clearance Time (h)	22.5	30.4	23.5

S. FL HES: South Florida HES Data
Trial 1: RtePM Population Data with HES parameters

Trial 2: Number of vehicles matched to FL HES

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 8: Monroe County			
Identifier	S. FL HES	Trial 1	Trial 2	Trial 3
Evacuation Zone	C	A/B	A/B	A/B
Total Population		89,438	81,308	81,308
Total Vehicles	29470	41737	29270	29270
Tot. Pop. Evacuating	51,007	62,606	58,541	58,541
Tot. Evac. to Shelters	1,092	0	0	0
Population Change (%)		10	0	0
People/Vehicle	1.7	1.5	2	2
% of Pop. Evac.	70	70	72	72
% using Private Vehicles		100	100	100
Response curve (h)	12	12	12	12
Background Traffic		None	None	High
In-County Clearance Time (h)	22.5	30.4	23.5	23.5

S. FL HES: South Florida HES Data
Trial 1: RtePM Population Data with HES parameters
Trial 2: Number of vehicles matched to FL HES
Trial 3: Trial 2 with High Background Traffic

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 8: Monroe County				
Identifier	**S. FL HES**	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**
Evacuation Zone	**C**	**A/B**	**A/B**	**A/B**	**A/B**
Total Population		**89,438**	**81,308**	**81,308**	**162,616**
Total Vehicles	**29470**	**41737**	**29270**	**29270**	**162616**
Tot. Pop. Evacuating	**51,007**	**62,606**	**58,541**	**58,541**	**162,616**
Tot. Evac. to Shelters	**1,092**	**0**	**0**	**0**	**0**
Population Change (%)		**10**	**0**	**0**	**100**
People/Vehicle	**1.7**	**1.5**	**2**	**2**	**1**
% of Pop. Evac.	**70**	**70**	**72**	**72**	**100**
% using Private Vehicles		**100**	**100**	**100**	**100**
Response curve (h)	**12**	**12**	**12**	**12**	**12**
Background Traffic		**None**	**None**	**High**	**High**
In-County Clearance Time (h)	**22.5**	**30.4**	**23.5**	**23.5**	**72**

S. FL HES: South Florida HES Data
Trial 1: RtePM Population Data with HES parameters
Trial 2: Number of vehicles matched to FL HES
Trial 3: Trial 2 with High Background Traffic
Trial 4: Max number of vehicles on the road

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 7: Broward County				
Identifier	**S. FL HES**	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**
Evacuation Zone	**B**	**A/B**	**A/B**	**A/B**	**A/B**
Total Population		**89,090**	**161,982**	**161,982**	**161,982**
Total Vehicles	**87330**	**22272**	**80991**	**80991**	**161982**
Tot. Pop. Evacuating	**178,775**	**44,545**	**161,982**	**161,982**	**161,982**
Tot. Evac. to Shelters	**8,268**	**0**	**0**	**0**	**0**
Population Change (%)		**10**	**100**	**100**	**100**
People/Vehicle	**2.0**	**2**	**2**	**2**	**1**
% of Pop. Evac.	**50**	**50**	**100**	**100**	**100**
% using Private Vehicles		**100**	**100**	**100**	**100**
Response curve (h)	**9**	**9**	**9**	**9**	**9**
Background Traffic		**None**	**None**	**High**	**High**
In-County Clearance Time (h)	**9.5**	**9.1**	**9.1**	**9.1**	**10.1**

S. FL HES: South Florida HES Data
Trial 1: RtePM Population Data with HES parameters
Trial 2: Number of vehicles matched to FL HES
Trial 3: Trial 2 with High Background Traffic
Trial 4: Max number of vehicles on the road

Florida HES: RtePM vs TIME Comparison

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	Operational Scenario 9: Miami-Dade County				
Identifier	S. FL HES	Trial 1	Trial 2	Trial 3	Trial 4
Evacuation Zone	D	D	D	D	D
Total Population		1,079,239	981,127	981,127	1,962,254
Total Vehicles	278185	350752	279621	279621	1962254
Tot. Pop. Evacuating	587,866	701,505	559,242	559,242	1,962,254
Tot. Evac. to Shelters	38,587	0	0	0	0
Population Change (%)		10	0	0	100
People/Vehicle	2.1	2	2	2	1
% of Pop. Evac.	65	65	57	57	100

Additional extensive analysis and validation is necessary to understand model behavior and validate clearance times. Reproducing all of Florida scenarios and clearance times using the HES Tool is recommended.

RtePM Functional Requirements

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Requirement	Justification
Increase the resolution of population data (currently at the census block)	FL, NYC, NC
Ability to model evacuations to destination point	FL, NC
Calculate clearance times for evacuations via public transportation	NYC
Ability for a user to define end points	FL, NYC, NC
Ability to assign weights to a group of end points	NYC, NC
Ability to upload additional road network data	FL, NYC, NC
Accurately model congestion	FL, NYC, NC
Phased Evacuations	TTI
Ability for user defined response curve	TTI, FL
Ability to accurately model seasonal population	TTI

Conclusion

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With some necessary improvements, RtePM is a viable candidate for transportation analysis model for the HES Tool.

- Microscopic models would offer more granular analysis, but would significantly increase the cost and complexity of use and it is unclear what the ROI is for large scale evacuation planning process
- Extensive validation and analysis of HES Tool/RtePM outputs is needed to understand RtePM behavior
- If additional functionality is added, RtePM can be used as a default model for Transportation Analysis in the HES Tool